

PATENT SPECIFICATION



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COMPLETE SPECIFICATION

Improvements in and relating to Methods of Making Tubular Heating Elements from Powdered Materials

We, METRO-CUTANIT LIMITED, a British Company, of Grappenhall, Warrington, Lancashire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Electrical resistance heating elements for operation at temperatures above 1,200°C. are usually made by pressing and sintering powders which are electrically conducting like metals. Preferred material are high melting point, oxidation resisting compounds or combinations of metal like carbides, borides, silicides, and the like. The heating elements are rod-like and have enlarged ends which serve to reduce the temperature of terminal connections thereon. The heat radiating surface must be comparatively large, therefore the diameter of such elements is usually between 10 and 50 mm. Furthermore it is advisable to make the elements hollow, that is tubular, to avoid excess temperatures in the centre portion of the element, while ensuring a large heat radiating surface, a comparatively small current carrying cross-sectional area, and great mechanical strength.

It has already been tried to produce such tubular heating elements by extruding powdered material containing a plasticiser, and also by pressing together annular layers.

However, it has not been possible to produce by these methods suitable heating elements which are strong enough to meet the mechanical requirements. If it is tried to mould the tubular bodies using steel dies and a mandrel, pressure being applied in a direction which is transverse to the longitudinal direction of the tube, the pressed body adheres to the mandrel so that it cannot be pushed out without damaging the body itself.

This drawback is overcome and a reliable method of making highly efficient heating elements is provided by the present invention which resides in a method of making a tubular heating element comprising mixing molyb-

denum silicide and a thermosetting resin in powder form with a plasticiser such as camphor and ether, pressing the mixture in a die using a mandrel, heating it whereby the resin hardens, and removing the mandrel after its cross section has been reduced, then sintering the thus moulded body.

The invention will be explained in greater detail with reference to exemplary embodiments.

A mixture of molybdenum silicide powder, a plasticiser such as camphor and ether, and an addition of a thermo-setting powdered resin is pressed using dies of steel and a mandrel of metal which is coated with a thin layer of wax, paraffin wax for instance. After the pressing operation the moulded body with the mandrel in it is subjected to a heat treatment by which the synthetic resin is hardened, and the wax coating on the mandrel is melted so that the hot mandrel can be readily removed. Then the moulded body is sintered at a high temperature.

In the above example reduction of the cross section of the mandrel after the pressing operation is achieved by melting the coating on the mandrel. However such a change in the core or mandrel cross section for loosening it inside the moulded body can be produced in different ways. For instance, the mandrel may be hollow and of elastic material so as to expand when a high pressure medium (under pressure of say 5,000—10,000 atmospheres) is applied to its hollow during the moulding operation. If the pressure of the medium in the mandrel is relieved the cross section of the core is reduced again, sufficiently for making the withdrawal of the mandrel possible.

Another possibility is to use a composite mandrel having a subdivided cross section so that the several parts can be removed one after the other, starting at the innermost portion.

What we claim is:—

1. Method of making a tubular heating

- element comprising mixing molybdenum silicide and a thermosetting resin in powder form with a plasticiser such as camphor and ether, pressing the mixture in a die using a mandrel, heating it whereby the resin hardens, and removing the mandrel after its cross section has been reduced, then sintering the thus moulded body.
2. Method as claimed in claim 1 wherein the mandrel comprises a core of metal coated with a thin layer of wax, the melting of which during the heating step causes reduction of the cross section of the mandrel.
3. Method as claimed in claim 1 wherein the mandrel is of elastic material and hollow, and is kept under high pressure, of the order of 5,000 to 10,000 atmospheres for instance, during the moulding operation after which pressure is released for reducing the cross section of the mandrel.
4. Method as claimed in claim 1 wherein the mandrel is subdivided to include inner and outer portions, and the first is removed before the removal of the latter, so that its cross section is reduced before its removal.
5. Method of making a tubular heating element substantially as hereinbefore described.
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